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TERTIARY VERTEBRATA OF THE WEST

Report of the United States Geological Survey of the Territories. F. V. Hayden, United States Geologist-in-Charge. Vol. III. "The Vertebrata of the Tertiary Formations of the West." Book I. By Edward D. Cope. (Washington, 1883-1884.)

THE American Government has in many ways shown the importance which it attaches to the diffusion of scientific knowledge; but in nothing has this been more clearly seen than in the care with which the results of the Geological Surveys have been published, and the liberality with which these works have been distributed; so that geologists on this side of the Atlantic are well acquainted with the magnificent quarto volumes in which the Reports of the Geological Survey of the Territories have been published. A number of these volumes had already appeared under the directorship of Dr. F. V. Hayden, when, in the year 1882, their publication was committed to the charge of Major J. W. Powell, Director of the United States Geological Survey. The work now before us is the first Report of the Survey of the Territories published since this change, and will take its place as the third volume of the series. While fully equal to the previous reports in the care bestowed upon the drawing and printing, it is by far the largest volume which has yet appeared, comprising, as it does, more than a thousand pages of letterpress and upwards of one hundred lithographic plates.

Prof. Cope began this work in 1872, and since then it has been carried on both in the field and in the study. It was originally intended that the Vertebrata of the "Cenozoic" and "Mesozoic" formations should form the third and fourth volumes of the Reports, but such a large amount of material has been obtained that it has become necessary to limit the work to the description of the "Cenozoic" Vertebrata, and this is to be divided into four parts, thus:—

Part I. Puerco, Wasatch, and Bridger Faunæ (Eocene).

Part II. White River and John Day Faunæ (Low. and Mid. Miocene).

Part III. Ticholeptus and Loup Fork Faunæ (Upper Miocene).

Part IV. Pliocene.

The present volume includes Part I. and Part II. as far as the Carnivora, the number of species described being 349, included in 125 genera, no less than 317 species having been determined by Prof. Cope.

The explorations, resulting in the acquisition of this splendid series of fossil Vertebrata, were conducted chiefly by the author himself, assisted by an efficient staff, and were carried on with much trouble and personal risk, not only on account of the inhospitable country in which part of the explorations had to be made, but also because of the hostility of the Cheyenne Indians, who, in certain regions, were during this time continually committing depredations and murders. No little credit is due to Prof. Cope and his able coadjutors for the manner in which this work was carried to so successful an issue in the face of many difficulties.

VOL. XXXIII.—NO. 844

Before entering upon the description of the fossils, a short account is given of the Tertiary formations in which they were found, and an interesting and valuable comparison is made with the strata of the same age in Europe. A significant circumstance, with which geologists are to some extent already familiar, is the different story, regarding the age of these beds, told by the plants and mammals. The determination of the age of the formations known as the Loup Fork, White River, Bridger, Wasatch, Green River, and Laramie Beds, arrived at by Prof. Cope from a study of their higher vertebrate faunæ, does not agree with the conclusions of Mr. Lesquereux derived from his examination of the plant remains. The table given at p. 44 shows, in each case, the Flora a whole period in advance of the Vertebrata; for example, while the Laramie plants have an Eocene facies, the Vertebrata indicate an Upper Cretaceous age; and the fauna and flora of each of the other formations show a similar discrepancy.

The numerous *Bulletins* and reprints with which Prof. Cope has liberally supplied us during the last few years have made us to some extent acquainted with the progress of the laborious task which he has undertaken, and with the names proposed for some of the new types of animals which have been discovered. Even with this knowledge, however, one is perplexed, on first opening the book, with the array of new names. The overwhelming amount of material which had to be dealt with, including such a multitude of new forms, no doubt made it necessary to establish many new genera and species, and these would require, in some instances, to be placed in new groups; but, notwithstanding this, it will probably be felt by many palæontologists that it would have been better in some instances to extend the limits of a group rather than to make new ones. Be that as it may, Prof. Cope has laid us under no little obligation by giving us such a clear and systematic account of his herculean labours.

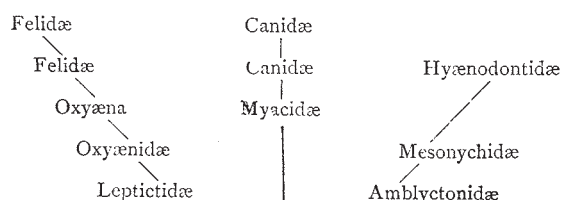
In the author's preface he touches upon the troublesome question of the rules of nomenclature. While agreeing with the law of priority, as generally understood, he gives half a dozen rules which have been adopted by a number of American biologists. The main principle underlying all these rules is, that a generic or specific name given by any author, without a sufficient description or definition, is not entitled to recognition by subsequent writers. To this principle no naturalist will be likely to take exception; but, unfortunately, the manner in which this rule has been applied by some authors has produced a result which it is most desirable to prevent, that is, an unnecessary multiplication of names. To take an instance, a writer (A.) describes a number of new species, giving them a generic name, without any definition, and, to quote Prof. Cope, "In these cases it is left to the reader (B.) to discover their characters. Should he do so, he becomes the real discoverer of the genus, and, as such, is entitled to name it." No doubt Mr. A. should have characterised his genus, and his name is *not entitled to be received*; but if Mr. B. is a true man of science, he will forego his right and "*habilitate the nomen nudum*," rather than burden his brother-workers with another addition to their load of synonyms, which is already a burden almost too heavy to be borne.

This volume is essentially a detailed description of

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genera and species, and as such is an extensive and invaluable mine of information, wherein palæontologists may work with profit for many years to come. But besides the more special descriptions, there is much of deep interest to the naturalist and evolutionist, a flood of light being thrown on the early Eocene forms, which were probably the progenitors of our existing mammals.

The Saurian genus *Champsosaurus*, hitherto known only from Cretaceous deposits, has now been found in the Puerco Tertiary series. The remarkable marsupial genus *Plagiaulax*, was originally described by Falconer from British Purbeck beds; within the last few years an almost identical genus has been met with in Tertiary strata in France; and now closely allied forms are made known to us from the American Tertiary groups. It is, however, among the higher mammalia that the most remarkable discoveries have been made. The finding of forms, less specialised than those living at the present day, has enabled Prof. Cope to trace what he believes to be the line of descent of some of the groups of living mammals. The determination of the characters of a considerable number of new genera and species, more or less closely allied to the *Insectivora*, has led to a new classification. It is proposed to include in a new order, called the *Bunotheria*, the sub-orders:—(1) *Creodonta*, (2) *Mesodonta*, (3) *Insectivora*, (4) *Tillodonta*, (5) *Taniodonta*, and (6) *Prosimia*? The *Creodonta* come nearest to the *Carnivora*, while the *Prosimia* come nearer to the *Quadrupedia*, groups (4) and (5) being distinguished by the possession of incisor teeth with persistent pulps. It is among the Eocene *Creodonta* that Prof. Cope finds the ancestors of the *Felidæ* and *Canidæ*. "In distinguishing between the ancestors of the *Felidæ* and *Canidæ*, we naturally seek to recognise in each an anticipation of the leading characters in the dentition which distinguish those families to-day" (p. 263). In the *Felidæ* we should expect a gradual abbreviation of the true molar series from behind. The *Canidæ*, on the other hand, not only retain the true molars, but have them also of a tubercular character. "Estimated by these tests the *Myacidæ* are clearly the forerunners of the *Canidæ*, and the *Oxyænidæ* of the *Felidæ*." The following diagram will show the families through which these relations are traced (p. 264):—



Unfortunately the new names prevent our fully appreciating these affinities, which can only be properly understood when the characters of these groups have been carefully studied. The forms allied to *Canis* which have been met with in the Lower and Middle Miocene are all said to be generically distinct from *Canis*, while those from the Upper Miocene pertain to the same genus. The many new species of *Carnivora* have suggested to Prof. Cope a new grouping for the *Fissipedia*. These are in the first place divided into two subdivisions:—

- (1) "External nostril occupied by the complex maxillo-

turbinal bone; ethmoturbinals confined to the posterior part of the nasal fossa; the inferior ethmoturbinal of reduced size . . . *Hypomyceteri*."

- (2) "External nostril occupied by the inferior ethmoturbinal and the reduced maxilloturbinal . . . *Epimyceteri*."

No. 1 includes the families *Cercopithecidæ*, *Procyonidæ*, *Mustelidæ*, *Æluridæ*, *Ursidæ*, *Canidæ*.

No. 2 the *Protelidæ*, *Arctictidæ*, *Viverridæ*, *Cynictidæ*, *Suricacidæ*, *Cryptoproctidæ*, *Nimravidæ*, *Felidæ*, *Hyænidæ*.

The species of *Carnivora* described are from the Miocene, and are all referable to the *Canidæ* and *Nimravidæ*, the first being divided into eight genera, all of which are represented except *Canis*; they have much resemblance to our dogs and foxes, and are separated chiefly by the modifications of their teeth. The second includes nine extinct genera, all closely allied to the *Felidæ*, but differing in having an alisphenoid canal and post-glenoid foramen. In some of them the dental formula is the same as that of the *Felidæ*; but in others there is an increase in the number of the molars and premolars. It is these variations which are used as generic distinctions. Some of the genera, such as *Pogonodon*, have the canine teeth so largely developed as to make a near approach to the sabre-toothed tigers.

The changes which are proposed in the names and grouping of the herbivorous animals are not less numerous or less radical than those among the flesh-eaters, to which allusion has been made above. The order *Ungulata*, as it is now generally understood, is to be divided into four orders, founded on characters of the carpus and tarsus; these are as follows:—

- (1) *Taxeopoda* (including sub-orders *Hyracoidea*, *Condylarthra*, and *Toxodontia*?).

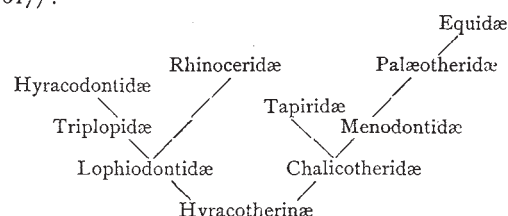
- (2) *Proboscidea*.

- (3) *Amblypoda* (including *Pantodonta*, *Dinocerata*, and *Talligrada*).

- (4) *Diplarthra* (including *Perissodactyla* and *Artiodactyla*).

The necessity for some modification of this classification is already pointed out by Prof. Cope himself, for on p. 383, in speaking of the almost perfect skeletons of *Phenacodus primævus* and *P. Vortmani*, which genus is placed in the *Condylarthra* (Order 1), he says:—"The unexpected result is, that this genus must be placed in a special group of an order which includes also the *Proboscidea*."

Not the least important outcome of these discoveries in the Eocene deposits is the reconstruction, from numerous specimens, of the genus *Hyracotherium*; and consequent upon this the knowledge that it is, as Prof. Cope thinks, the earliest ancestor of the *Perissodactyla*. The following genealogical tree will show this relationship (p. 617):—



The *Hyracotherinae* are here made the parent stock from which are supposed to have arisen, on the one side, the horses, through the *Palæotheria*; the tapirs being an offshoot from an ancient group, the *Chalicotheridæ*. On the other side the rhinoceroses have arisen from the *Lophiodonts*, from which also the *Hyracodonts* are to be traced.

Time alone will show whether the systems of classification proposed by Prof. Cope are founded on sufficiently important characters to render them permanent. It is probable that naturalists will hesitate before accepting such sweeping changes, especially as they necessitate the adoption of so many new ordinal names. However, it will be well to wait until we have had time to make ourselves thoroughly acquainted with the details of this work, before criticising that which is the result of years of patient labour. We are certainly under deep obligation to the author for his careful and systematic marshalling of the multitude of facts with which he has had to deal; and congratulate him, as well as the directors of the two Surveys, on the successful completion of this first half of the work, which will be a lasting testimony to the zeal and devotion of all who have shared in the labour of its production, and an enduring monument to its author's scientific skill and untiring energy.

E. T. NEWTON

THE DEPTHS OF ALPINE LAKES

La Faune profonde des Lacs suisses. Par le Dr. F. A.

Forel, de Morges, Professeur à l'Académie de Lausanne. (Bâle, Genève et Lyon: chez H. Georg, 1885.)

PROFESSOR FOREL, of Morges, already so well known by his numerous pamphlets and short notices on various points in the natural history and the physical geography of the great lake beside which he lives, has in the present work given us the results of the labours of many years, casting into one mass the many fragments and gathering together and correcting where needful the many interesting papers which alone he has hitherto published.

It is a small quarto volume of over 200 pages, with a table of contents and a long bibliographical list appended; it is a pity that there is no index, and the value of the work would have been greatly enhanced had it been illustrated with figures of the new or rare species, and especially with a map of the basin of one at least of the Alpine lakes. Though it professedly deals with the deep-water fauna of the Swiss lakes as a whole, and though frequent allusions and references are made to work done by Prof. Forel and others in a very large number of these and of other lakes, this memoir, as is natural, deals most fully with the fauna of one lake only—the Léman. Of the only other great lake on the northern slope of the Alps—the Bodensee—and of the great lakes of the southern slope—Verbano, Lario, and Benaco—we are told but little. This is, however, a matter of the less importance as the physical surroundings which have affected the fauna of the Léman are almost exactly repeated in the other lakes, and the little that is known of their deep-water life is very similar to what we know of that of the Léman. Of this—his own lake—

Prof. Forel has given us a study which may be called complete.

The chief agents affecting the life of the lake are temperature and light: of less importance are the shape and capacity of its basin, the matters dissolved in or held in suspension by its waters, the movements—for the most part superficial—to which its waters are subject. And light is a far more important factor than temperature,—it is at a depth of 30 metres, at the depth that is to say at which chlorophyll-forming vegetation ceases that Prof. Forel draws the line separating the littoral and deep regions of the lake: the actinic action of light ceases at 50 metres in summer, at 100 metres only in winter, owing to the greater transparency of the waters at that season.

Speaking of the conditions of this deep region Prof. Forel says: "They all tend to calm, to rest, to absence of movement. Uniformity, monotony, equality, no motion, no variation, such are the general characters of this region, with which we can compare no other region but that of the deep sea." It is after having studied the flora and fauna of this region almost uninterruptedly for six years that he now gives us what he modestly calls a sketch of the results at which he has arrived.

But in order to be able properly to understand the deep-water life of the lake we must first be properly acquainted with the inhabitants of the upper waters, whether of the shore or of the open. To this end, the first half of the book is occupied with a careful account of the littoral and pelagic flora and fauna. The most interesting point in this section is the statement that the same species of pelagic Entomostraca are common not only to the Alpine lakes but to those also of Scandinavia and the Caucasus. They exist in enormous numbers, thousands of individuals may be captured in one sweep of the net, and they form a very important part of the food of fishes, giving to them, it appears, their characteristic fishy smell; but the species are few. The very wide distribution of these few species is probably brought about by migratory water-fowl.

The deep-water flora of the Léman finds its lowest limit at a depth of 100 metres, and consists entirely of Algæ, chiefly *Palmellaceæ* and *Diatomaceæ*, of which the latter are the most abundant in species, but the *Palmellaceæ* are the most important, forming in many places a felted carpet on the surface of the ooze, and thus giving a more solid bottom, on which animals may move or in which they may live.

The population is much denser in the upper part of the deep region than in the lower part, but even in the deepest part life is present; in the upper part hundreds of animals, dead or alive, may often be obtained at one haul. About 100 species (22 of which are new) constitute this fauna:—Fishes, 14; Insects, 3; Arachnida, 9; Crustacea, 16; Hydroidea, 1; Rhizopoda, 13; Cilioflagellatæ, 1; Gasteropoda, 4; Lamellibranchiata, 2; Annelida, 4; Nematodea, 3; Cestoidea, 1; Turbellariæ, 18; Bryozoa, 1; Rotifera, 2.

The greater part of these species are evidently the descendants of the inhabitants of the shallow waters, and differ from them chiefly in being smaller and less brightly coloured; the eyes are wanting in *Gyrator coccus*, and have a tendency to disappear in other species; the shells